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MATTERS RELATING TO LIFE SCIENCES, INCLUDING SPACE MEDICINE

Results of space-related research in the Netherlands

Working paper submitted by the Netherlands

Coordination of the activities related to space science is a task conducted by Space Research Organization Netherlands (SRON). Several institutes have programmes in which some kind of research related to space is performed.

Recently no medical experiments in outer space have been conducted. Space science related medical studies were done at the following institutes:

Institute for Perception, Soesterberg (Dr. W. Bles, Dr. J. T. Marcus)

Vestibular physiology is the main theme.

1. High g-load effects were studied in former European Space Agency (ESA) astronauts with the goal of gaining more insight into the development of space sickness. This project was done in close cooperation with the Technical University Delft (Aviation Department) and the University of Amsterdam (Medical Faculty, ENT Department).

Results. A hypothesis was published about the genesis and development of space sickness.

2. Vertical eye movements were studied in humans subjected to accelerations in the human centrifuge.

Results. A vertical nystagmus accompanied by rumbling sensations points to a specific stimulation condition of the vertical canals.

University of Amsterdam, Medical Faculty, Department of Internal Medicine (Dr. J. M. Karemaker, Dr. W. Wieling)

Blood pressure measurements. Blood pressure was measured with a recently developed device, the fini press, which is able to acquire information from a subject's finger.

Results. During parabolic flight, blood pressure changes were measured in human subjects. In upcoming experiments, the device will be used and the blood pressure profile will be subjected to further studies.

Department of Otorhinolaryngology (Prof. Dr. W. J. Oosterveld, Dr. H. A. A. de Jong, Dr. H. W. Kortschot); Section: vestibular system

Four experiments were conducted in ESA's parabolic flight campaign at Brétigny, France, with the use of the Caravelle 234.

1. Vestibular tests during weightlessness

The mechanism of the caloric test, which is clinically of great importance, is not yet clear. This test was performed during weightlessness in human subjects in parabolic flight. The test was carried out in different head positions of the subjects in order to define an optimal test procedure.

Results. The horizontal and vertical components of a caloric-induced nystagmus were studied during parabolic flight. Human subjects were tested in three different positions. In inflight calorizations, the water irrigation was finished just before the start of the pull-up of the manoeuvre of the aircraft. Thus the first period of weightlessness took place during the optimum caloric response, 60-90 seconds after the start of the irrigation.

- Both horizontal and vertical nystagmus components decreased or faded away completely during the microgravity period;
- These components recovered during the pull-out and reached values similar to the ones found during the pull-up;
- In prone position (face down) in all tests, the subjects showed a direction of the horizontal slow nystagmus component opposite to that found in supine position (face up);
- The decrease and disappearance of the caloric vestibular nystagmus during short-duration microgravity does not require additional sensory influences.

In several test subjects, the horizontal and vertical components of the caloric nystagmus showed a different time course. Thus further investigations on an additional influence of the vertical canal and/or otolithic sensory system are required.

2. Pupil size measurements during weightlessness

Studies in animals have shown that in some species neurological pathways exist between the balance organs and the ocular muscles which serve pupil dilation and constriction. The meaning of this structure is not known. The pupil size was measured both during weightlessness in parabolic flight and during high g-load experiments in a human centrifuge.

Results. The experiments made clear that "vestibular ocular" pathways most probably exist in humans as well, connecting the nucleus of Edinger Westphal with the vestibular nuclear complex. With these results the close relationship between vision and such vestibular symptoms as vertigo and dizziness became more clear. The theory was further supported by findings in experiments at the ESA Space Sled at the Institute for Perception (Soesterberg) and with the aid of a human centrifuge (Netherlands Institute for Aviation and Space Medicine, Soesterberg).

3. Cervical column

Movements of the cervical column are able to induce vertigo in man. This is assumed to be caused either by signals from pressure-detecting devices in the cervical muscles or by direct gravitational effects on the cervical nerve roots.

An investigation was carried out with human test subjects who had to make special head movements according to a special programme in the weightless periods in parabolic flight. Most probably, pressure devices in the cervical muscles are the main source of signals during head movements with a fixed head. Under normal gravity conditions, vascular components as well as irritation of the cervical nerve roots also play a role. In microgravity these two components diminish while the action of the pressure devices becomes more imminent.

A rotation chair programme was conducted in parabolic flight. The body was rotated in the horizontal plane with a fixed head.

Results. The cervical pressure devices in the muscles proved to be the main component in eliciting cervical-induced movements and vertigo. For clinical test procedures, the method described above will be further developed to gain extensive information about the condition of the cervical structures in patients suffering from cervical-related vertigo and balance disorders.

4. Swimming behaviour of fish in weightlessness

Fish belong to those species on Earth accustomed to life in a real three-dimensional spatial environment where gravity is the only reference for orientation. This makes the fish a unique test animal for behaviour studies in low-gravity fields.

Experiments in parabolic flight were conducted in three different conditions:

(1) Normal fish, species goldfish;

(2) Blind fish (Anophtichtus jordanii) which lack a visual system as a component in their orientation system;

(3) Fish which have been operated upon so that they are artificially blinded.

Results. Preliminary results show that for fish the vestibular organs are extremely important, perhaps even the most important component in swimming behaviour, as well as in positioning activities with regard to the direction of gravity. To explore the importance of the vestibular components in relation to each other as well as the consequences of circumscribed lesions in the system, a protocol has been designed for experiments in the ESA parabolic flight campaign.